Disruption Tolerant Networking (DTN)

Completed Technology Project (2011 - 2019)

Project Introduction

Traditionally, space communication systems have relied on dedicated point-to-point or single-hop relay links. Such links are not always available, often have long time delays, and are limited in number. A networked communication architecture is desired to support future space missions, as networked communications significantly increase the operational flexibility and robustness of missions, as well as enable mission classes otherwise untenable. However, the terrestrial Internet protocols do not work well in highly disrupted and delayed environments, and new protocols are needed.

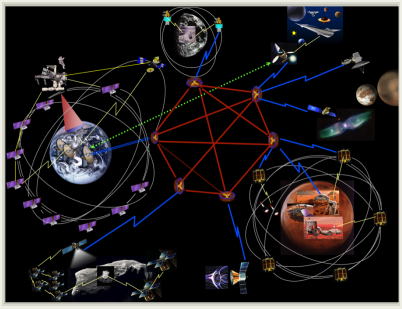
The goal of the AES Disruption Tolerant Networking (DTN) project is to develop and deploy a protocol suite that extends the terrestrial Internet capabilities into highly stressed data communication environments where the conventional Internet protocols do not work well. The DTN protocol suite is also being internationally standardized and will enable a Solar System Internet (SSI) architecture to support future space missions.

DTN is a suite of protocols that extends the terrestrial Internet capabilities into highly stressed data communication environments where the conventional Internet does not work well. These environments are typically subject to frequent disruptions, unidirectional links, possibly long delays, and high error rates.

The DTN protocol suite can run over the existing Internet Protocol (IP) suite or it can operate by itself as a full Internetworking protocol. DTN provides assured delivery of data using an automatic store-and-forward mechanism. The DTN suite also contains network management, security, routing, and quality-of-service mechanisms.

DTN is being standardized by the Consultative Committee for Space Data Systems (CCSDS) and the Internet Engineering Task Force (IETF), and all of the DTN protocols will be open international standards, supported by open-source software. Several DTN implementations exist and are publicly available, including NASA's Interplanetary Overlay Network (ION) implementation (http://sourceforge.net/projects/ion-dtn/).

This AES project was transferred to the NASA Human Exploration and Operations Mission Directorate (HEOMD) Space Communications and Navigation (SCaN) Program, October 2020.



Solar System Internet Concept

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Anticipated Benefits

- **Improved Operations and Situational Awareness:** The DTN store-and-forward mechanism along with automatic re-transmission provides more insight into events during communication outages and significantly reduces the need for ground-based scheduling.
- **Interoperability and Reuse:** A standardized DTN protocol suite enables interoperability of multi-agency communication assets and also allows NASA to use the same communication stack for future missions (low Earth orbit, near earth objects, or deep space).
- **Space Link Efficiency, Utilization and Robustness:** DTN enables more reliable and efficient data transmissions resulting in more usable bandwidth. DTN also improves link reliability by having multiple network paths and assets for potential communication hops.
- **Security:** The DTN Streamlined Bundle Security Protocol (SBSP) allows for integrity checks, authentication and encryption, even on links where not previously used.
- **Quality-of-Service:** The DTN protocol suite allows for many priority levels to be set for different data types, ensuring that the most important data is received ahead of less important data.

Missions operated using an internet and automated mission communications can result in more data from spacecraft and reduced operations costs.

DTN is being standardized by the Consultative Committee for Space Data Systems (CCSDS) and the Internet Engineering Task Force (IETF), and all of the DTN protocols will be open international standards, supported by open-source software that is freely available to Industry for incorporation into their products.

DTN can be used by other agencies to enable reliable, automated, and internetworked communication in disrupted environments, potentially resulting in more data return and reduced operations costs. Other agencies may also be able to leverage NASA assets as part of the Solar System Internet.

Organizational Responsibility

Responsible Mission Directorate:

Exploration Systems Development Mission Directorate (ESDMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Exploration Capabilities

Project Management

Program Director:

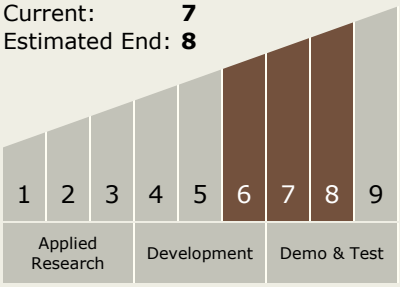
Christopher L Moore

Project Manager:

Brenda E Lyons

Technology Maturity (TRL)

Start: **6**
Current: **7**
Estimated End: **8**



Technology Areas

Primary:

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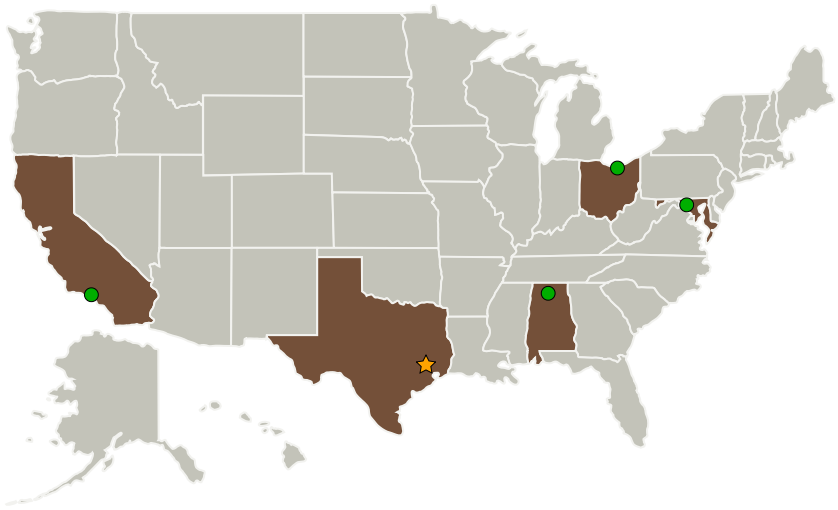
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
●Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio
●Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland
●Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California
Johns Hopkins University Applied Physics Laboratory(JHU/APL)	Supporting Organization	R&D Center	Laurel, Maryland
●Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama
The MITRE Corporation	Supporting Organization	Industry	McLean, Virginia

Technology Areas *(cont.)*

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.3 Internetworking
    - TX05.3.1 Disruption Tolerant Networking

Target Destinations

Earth, The Moon, Others Inside the Solar System

Supported Mission Type

Planned Mission (Pull)

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Primary U.S. Work Locations	
Alabama	California
Maryland	Ohio
Texas	

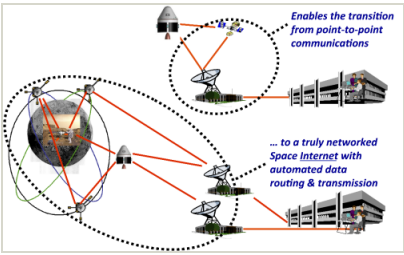
Project Transitions

October 2011: Project Start

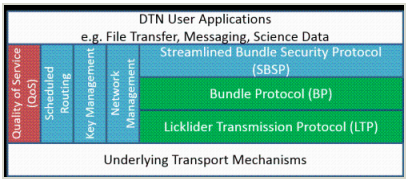
September 2019: Closed out

Closeout Summary: This AES project was transferred to the NASA Human Exploration and Operations Mission Directorate (HEOMD) Space Communications and Navigation (SCaN) Program, October 2020.

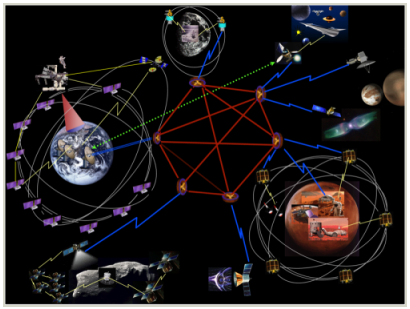
Images



Disruption Tolerant Networking (DTN)
Disruption Tolerant Networking (DTN)
(https://techport.nasa.gov/image/40797)



DTN Protocol Suite
DTN Protocol Suite
(https://techport.nasa.gov/image/40799)



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(https://techport.nasa.gov/image/40798)

Stories

Infusion Story - DTN and International Space Station
(https://techport.nasa.gov/file/62318)

Project Website:

https://www.nasa.gov/content/dtn